International Journal of Computational and Experimental Science and ENgineering (IJCESEN)

Vol. 11-No.4 (2025) pp. 7464-7472
http://www.ijcesen.com

ISSN: 2149-9144

Research Article

Role of the Saudi Red Crescent Authority in Out-of-Hospital Cardiac Arrest Survival Rates

Abdullah Hassan Almuhanna[1]*, Mustafa Ali Almyad[2], Zaki Hassan AL Abdullah[3], Murtada Abdullah Al Hajji[4], Abdullah Ali Alatiyyah[5], Najeeb Mahfouza Alhajji[6], Abdulhameed Ahmad Alhajji[7], Luay Mohammed Ali Aldajani[8], Ali Nasser Yahya Hazazi[9], Abdullah Hejji Alghareeb[10]

[1]Emergency Medical Services technician, Albathaa, Saudi Red Crescent Authority,
* **Corresponding Author Email:** abduuullah1985@gmail.com- **ORCID:** 0000-0002-5200-7850

[2]Emergency Medical Services technician, Saudi Red Crescent Authority,
Email: mstfyalmyad7@gmail.com - **ORCID:** 0000-0002-5240-7850

[3]Emergency Medical Services Technician, Qatif Sector, Saudi Red Crescent Authority,
Email: Hkzaki@hotmail.com- **ORCID:** 0000-0002-5249-7850

[4]Emergency Medical Services Technician, Qatif Sector, Saudi Red Crescent Authority,
Email: Swklm7568@gmail.com- **ORCID:** 0000-0002-5248-7850

[5]Emergency Medical Services Technician, Alsalmania, Saudi Red Crescent Authority,
Email: abdullahali-1408@hotmail.com - **ORCID:** 0000-0002-5246-7850

[6]Emergency Medical Services technician, Eastern Villages Ambulance Center, Saudi Red Crescent Authority,
Email: Mnmayh997@gmail.com - **ORCID:** 0000-0002-5245-7850

[7]Emergency Medical Services technician, Saudi Red Crescent Authority,
Email: hameeed29121401@yahoo.com- **ORCID:** 0000-0002-5244-7850

[8]Dammam, Emergency medical service technician, Saudi Red Crescent Authority,
Email: loai003300@gmail.com- **ORCID:** 0000-0002-5243-7850

[9]Emergency Medical Services technician, Ras Tanurah, Saudi Red Crescent Authority,
Email: aliali0644@gmail.com- **ORCID:** 0000-0002-5242-7850

[10]Emergency Medical Services technician, Empty Quarter, Saudi Red Crescent Authority,
Email: gahreeb99@gmail.com - **ORCID:** 0000-0002-5241-7850

Article Info:

DOI: 10.22399/ijcesen.4048
Received : 03 January 2025
Accepted : 28 January 2025

Keywords

Saudi Red Crescent Authority,
out-of-hospital cardiac arrest,
OHCA,
survival rates,
emergency medical services,
training programs

Abstract:

The Saudi Red Crescent Authority (SRCA) plays a critical role in improving out-of-hospital cardiac arrest (OHCA) survival rates across Saudi Arabia through its comprehensive emergency medical services (EMS). By implementing extensive training programs for its personnel and collaborating with local hospitals, the SRCA ensures that emergency responders are equipped with the necessary skills to deliver timely and effective cardiopulmonary resuscitation (CPR) and defibrillation. Moreover, the SRCA actively propagates public awareness initiatives to educate citizens on recognizing cardiac arrest symptoms and the importance of calling emergency services immediately. These efforts aim to create a robust community response system, thereby increasing the chances of survival for individuals experiencing cardiac arrest outside hospital settings. In addition to direct emergency care, the SRCA's strategic deployment of automated external defibrillators (AEDs) in public spaces significantly enhances the likelihood of effective resuscitation during OHCA incidents. The organization routinely partners with educational institutions and local businesses to install AEDs and conduct CPR training workshops, empowering citizens to take immediate action in emergencies. Furthermore, the SRCA collects and analyzes data on cardiac arrest incidents, allowing for ongoing evaluation and improvement of their response strategies. These multifaceted approaches not only bolster OHCA survival rates but also contribute to

fostering a culture of preparedness and responsiveness regarding cardiac emergencies throughout the Kingdom.

1. Introduction

Out-of-hospital cardiac arrest (OHCA) represents one of the most critical and time-sensitive medical emergencies worldwide, where the immediate cessation of heart function demands a rapid, coordinated, and effective response to prevent irreversible death or severe neurological damage. It is a leading cause of mortality globally, claiming millions of lives each year and presenting a formidable challenge to public health systems [1]. The "chain of survival" metaphor—comprising immediate recognition and activation, early cardiopulmonary resuscitation (CPR), rapid defibrillation, advanced life support, and integrated post-cardiac arrest care—provides the foundational framework for managing OHCA [2].

The SRCA has evolved from a basic transport service into a sophisticated, technology-driven medical response organization. Its mandate extends across the vast and geographically diverse landscape of the Kingdom, from dense urban centers like Riyadh and Jeddah to remote desert and mountain communities. This operational scope is supported by a substantial infrastructure, including a fleet of over 2,000 advanced life support ambulances, more than 450 stations, and a unified emergency communication center (accessed via 911) that handles millions of calls annually [3]. The SRCA's strategic vision is deeply aligned with Saudi Vision 2030's goals for a healthy society, emphasizing the enhancement of healthcare services and the improvement of response times to emergencies, which are critical factors in determining OHCA outcomes [4].

The epidemiological burden of OHCA in Saudi Arabia is significant and reflects both global trends and unique regional characteristics. While comprehensive national registry data is still being expanded, recent studies from major urban centers provide alarming insights. It is estimated that the incidence of emergency medical services-treated OHCA in cities like Riyadh is approximately 25 to 30 cases per 100,000 population annually [5]. The overall survival rate to hospital discharge for OHCA victims in the Kingdom, however, remains low, with recent reports indicating figures between 2% and 4%, a statistic that underscores the severe challenge at hand and the critical need for system-wide improvements [6]. This survival rate is influenced by a complex interplay of factors, including low rates of bystander CPR—estimated to be below 20% in some regions—and prolonged response times in certain areas, which can push the critical "call-to-shock" interval beyond the life-saving 5-10 minute "platinum period" [7].

The core mission of the SRCA in the context of OHCA is to fortify every link of the chain of survival where its intervention is pivotal. This begins with the **emergency call and dispatch** phase. SRCA call-takers are trained to recognize potential cardiac arrest using standardized protocols, allowing for the immediate dispatch of resources and the provision of telephone-assisted CPR (T-CPR) instructions to bystanders, a proven intervention that can double or triple the chance of survival [8]. Upon arrival, SRCA paramedics are equipped to perform **high-quality CPR and rapid defibrillation**. The widespread deployment of Automated External Defibrillators (AEDs) across its fleet ensures that a life-saving shock can be delivered on scene. The integration of mechanical CPR devices in some advanced units helps maintain consistent, high-quality chest compressions during the challenging process of patient transport [9].

Furthermore, the SRCA's role extends into **advanced life support (ALS)**, where paramedics are trained to secure advanced airways, administer crucial medications like epinephrine, and obtain intravenous access, all according to the latest international resuscitation guidelines [10]. A critical and often overlooked component is **pre-hospital notification and transport**. The SRCA's communication systems enable paramedics to alert the receiving hospital of an incoming OHCA patient, allowing the cardiac catheterization lab and intensive care team to prepare for immediate post-resuscitation care, which is vital for preserving neurological function [11].

Despite these structured efforts, the SRCA operates within a challenging ecosystem. The low prevalence of bystander CPR, cultural hesitancies, traffic congestion in metropolitan areas, and the vast distances in rural regions create significant barriers to achieving optimal response times and, consequently, better survival rates [12].

2. The Burden of Out-of-Hospital Cardiac Arrest in Saudi Arabia:

The precise incidence of OHCA in Saudi Arabia is an area of ongoing research, as the establishment of a comprehensive, Utstein-style national registry is still evolving. However, regional studies and data from major urban centers provide a revealing picture. Recent research from the Riyadh region estimates the incidence of EMS-treated cardiac

arrest to be between 25 and 35 per 100,000 people annually [13]. When extrapolated to the Kingdom's population of over 32 million, this suggests that emergency services respond to thousands of OHCAs each year. A significant proportion of these events, approximately 70-80%, occur in private residences, which presents a particular challenge for rapid recognition and intervention, as they are often unwitnessed [14]. This incidence rate places Saudi Arabia within an intermediate range compared to global data, which shows wide variation from under 30 to over 100 per 100,000 population in different countries, but the low survival rates indicate a critical gap between occurrence and positive outcome [15].

Demographically, the profile of OHCA victims in Saudi Arabia reflects the Kingdom's unique population structure and emerging health challenges. The average age of OHCA patients is notably younger than in Western and East Asian countries, often falling in the 50-65 year age range, which can be attributed to the nation's relatively youthful population pyramid [16]. There is a pronounced male predominance, with males accounting for over 70% of cases, a trend consistent with global patterns but potentially amplified by regional lifestyle and occupational risk factors [14].

From an etiological standpoint, the leading cause of OHCA in Saudi Arabia is coronary artery disease, which is closely linked to the high and rising prevalence of cardiovascular risk factors within the population. These include a high rate of diabetes mellitus, hypertension, and dyslipidemia, all of which contribute to the burden of sudden cardiac death [17]. However, a notable distinction in the Saudi context is the significant proportion of OHCAs attributed to non-cardiac causes, particularly major trauma from road traffic accidents (RTAs). As RTA rates in the Kingdom are among the highest globally, they contribute substantially to the OHCA caseload, introducing complex resuscitation scenarios for EMS personnel that often involve traumatic and hemorrhagic causes alongside primary cardiac arrest [18].

The most telling metric of a system's effectiveness in managing OHCA is the survival rate, and here the data reveals a substantial opportunity for improvement. The overall survival-to-hospital-discharge rate for OHCA in major Saudi cities remains dismally low, with recent studies reporting figures between 2% and 4% [13, 19]. This stands in stark contrast to survival rates in high-performing systems in North America, Europe, and parts of Asia, where rates of 10% or higher are increasingly common. The analysis of survival reveals critical determinants. The single most significant predictor of survival is a shockable initial cardiac rhythm, such as Ventricular Fibrillation (VF) or Pulseless Ventricular Tachycardia (VT). However, the proportion of OHCAs found in a shockable rhythm by SRCA paramedics is often below 20%, which is lower than many international averages [19]. This low percentage is frequently linked to prolonged response times; as the time from collapse to rhythm analysis increases, VF deteriorates into non-shockable rhythms like asystole. Consequently, survival rates for patients found in a shockable rhythm are significantly higher, but they still trail behind global benchmarks due to other systemic challenges.

A critical breakdown in the "chain of survival" within the Kingdom is the low rate of bystander intervention. Multiple studies from different regions of Saudi Arabia consistently report that bystander CPR is performed in less than 20% of witnessed OHCAs before the arrival of EMS [14, 20]. This is one of the lowest rates reported internationally and represents a catastrophic failure of the first link in the chain. The reasons are multifaceted, including a lack of mandatory CPR training in school and driver's education curricula, cultural hesitancy to perform the procedure, and a lack of public awareness about its life-saving importance. This lack of immediate CPR drastically reduces the window of opportunity for successful defibrillation and advanced life support, directly contributing to the low survival statistics. Furthermore, the use of Public Access Defibrillators (PADs) by bystanders is exceptionally rare, as public AED programs are not yet widespread or well-integrated into public consciousness and infrastructure.

3. The SRCA Response Framework:

The first link in the SRCA's professional response chain is the **Emergency Communication Center**. Operating under the unified national emergency number (911), these centers are the nerve center for all pre-hospital emergencies. When a call related to a potential cardiac arrest is received, it triggers a highly structured and time-sensitive protocol. The initial challenge is the accurate and rapid **recognition of OHCA** by the call-taker. Dispatchers are trained to use standardized, algorithm-based interrogation scripts to identify key indicators, such as a patient who is unconscious and not breathing normally. The distinction between agonal gasping and normal breathing is a critical skill, as agonal respirations are present in up to 40% of OHCAs and can be misinterpreted by laypersons as a sign of life, leading to catastrophic delays in CPR [21]. To enhance accuracy, the SRCA has been implementing Advanced Medical

Priority Dispatch System (AMPDS) protocols, which provide a structured framework for questioning callers and assigning a determinant code that dictates the response priority and resources [22].

Simultaneously with the dispatch of units, the call-taker initiates the second crucial intervention: **Telephone-assisted CPR (T-CPR)**. Recognizing that bystander CPR is the single most effective intervention to bridge the gap until EMS arrival, SRCA dispatchers are trained to provide calm, clear, and concise instructions to callers on how to perform chest compressions. The protocol typically emphasizes hands-only CPR for untrained lay rescuers, simplifying the process and increasing the likelihood of compliance. The effectiveness of T-CPR is well-established; it can double or triple the chance of survival [23]. However, its success in the Saudi context is hampered by the previously noted low baseline rates of bystander intervention. Cultural hesitancy, fear of causing harm, and a lack of prior training can lead to caller refusal or difficulty in following instructions under extreme stress, presenting a significant challenge that the SRCA must overcome through public education and continuous dispatcher training [24].

While the call-taker manages the human element, the **Computer-Aided Dispatch (CAD) system** executes the logistical response. The moment a high-acuity determinant like cardiac arrest is entered, the CAD system springs into action. Using sophisticated algorithms and real-time Global Positioning System (GPS) data from the entire fleet, it identifies and dispatches the closest available advanced life support (ALS) unit to the scene. The integration of live traffic data feeds allows the system to predict travel times dynamically and may even suggest optimal routes to avoid congestion [25]. In metropolitan areas like Riyadh and Jeddah, where traffic can be a major impediment, this intelligent resource allocation is vital. The SRCA's reported average response time of under 15 minutes in urban centers is a testament to this system, though this metric itself reveals a core challenge: for OHCA, where the "platinum minutes" demand intervention within 5-10 minutes, a 15-minute response often means arriving to find a patient in a non-shockable rhythm, with a vastly diminished chance of survival [26].

Upon arrival at the scene, the SRCA paramedics' actions are guided by rigorous protocols designed to minimize any further delay in delivering life-saving care. The first step is a rapid **scene size-up and patient assessment** to confirm cardiac arrest. The team immediately checks for responsiveness, breathing, and a pulse, a process that should take no more than 10 seconds. Once OHCA is confirmed, the team initiates a choreographed sequence of interventions. High-quality CPR begins immediately, often with one paramedic starting compressions while the other prepares the **Automated External Defibrillator (AED)**. The use of AEDs is standard across the SRCA fleet; the devices are applied, and the rhythm is analyzed at the earliest possible moment. If a shockable rhythm (VF/pVT) is identified, a shock is delivered without delay [27]. The integration of mechanical CPR devices (e.g., LUCAS™) in some SRCA units is a significant advancement, as it allows for consistent, high-quality compressions to be maintained without interruption during movement from difficult locations (e.g., high-rise buildings without elevator access) or during patient transport, a period where manual CPR quality typically deteriorates [28].

A critical factor influencing the "scene time" is the **operational environment**. OHCA in a private residence presents different challenges than one in a public space. In homes, paramedics often face cramped spaces, distraught family members, and the potential need to move the patient to a more suitable area for resuscitation. In contrast, public locations may offer more space but can involve crowd control issues. Furthermore, the SRCA's mandate covers the entire Kingdom, leading to a stark **urban-rural disparity**. While an urban unit might achieve a 12-minute response, a rural unit facing vast distances and potentially difficult terrain might have a response time exceeding 30 minutes [29]. In these scenarios, the fundamental premise of the "chain of survival" is broken, as the window for meaningful intervention has almost certainly closed before EMS even arrives. This highlights the absolute necessity of strengthening community-based first response and public AED programs in these remote areas to act as a stopgap [30].

4. Bystander Intervention and Community Engagement:

The statistics surrounding bystander intervention in Saudi Arabia reveal a critical public health gap. Multiple studies conducted in different regions of the Kingdom consistently report that bystander CPR is performed in less than 20% of witnessed OHCA cases before EMS arrival [31, 32]. This figure stands in stark contrast to high-performing systems in countries like Sweden, the Netherlands, and parts of the United States, where bystander CPR rates can exceed 70-80% [33]. The consequence of this gap is profound. For every minute that passes without CPR, the chance of survival from a shockable cardiac arrest decreases

by 7-10% [34]. Therefore, in a typical urban Saudi response time of 12-15 minutes, the near-absence of bystander CPR for the first 10+ minutes almost guarantees a fatal outcome, regardless of the proficiency of the subsequent professional response. The low rate of Public Access Defibrillator (PAD) use is even more negligible, with public AEDs being deployed by bystanders in less than 1% of cases, reflecting their limited availability and public unfamiliarity [35].

Understanding the barriers to bystander intervention is essential for designing effective countermeasures. Research specific to the Saudi context has identified a complex web of cultural, educational, and systemic obstacles. A primary barrier is a **pervasive lack of knowledge and training**. CPR is not a mandatory component of the national school curriculum or driver's licensing process, denying millions of citizens exposure to this fundamental life skill [36]. Furthermore, there are significant **cultural and psychological hesitancies**. These include a fear of causing further harm to the victim, religious concerns regarding physical contact with strangers, especially between genders, and a general apprehension about performing a medical procedure without formal certification [37]. This is compounded by a **diffusion of responsibility** in public settings, where individuals may assume someone else is more qualified or that emergency services will handle the situation. The **low public visibility of AEDs** and a lack of awareness about their simple, automated operation further cripple the potential of this technology to save lives.

Recognizing this systemic weakness, the SRCA has initiated several community engagement and public education programs. The most prominent of these is the **"Nafith" (We Can) initiative**, a national campaign designed to raise public awareness about the importance of bystander CPR and to provide basic, hands-only CPR training. Through health fairs, school visits, and public events, SRCA volunteers demonstrate compression-only CPR and encourage public participation [38]. While a step in the right direction, the reach and depth of such programs remain limited compared to the scale of the need. Training thousands of people in brief sessions is commendable, but without frequent reinforcement and skills retention programs, the long-term competency of these "trained" bystanders is questionable. Studies show that CPR skills decay significantly within 6-12 months without refresher training [39]. Therefore, these initiatives, while valuable for raising awareness, may not be sufficient to create a critical mass of truly confident and competent responders.

A more strategic and potentially transformative approach lies in **legislative and institutional mandating** of CPR training. Making CPR a graduation requirement for all high school students would ensure that every new generation enters adulthood with this essential skill. Similarly, incorporating CPR training into the requirements for obtaining a driver's license, a model successfully implemented in many countries, would capture a large and relevant segment of the population [40]. For the PAD component, a national strategy is required. This involves not only increasing the number of AEDs in strategic locations like shopping malls, airports, and large mosques but also integrating their locations into the SRCA's dispatch system. Innovative solutions such as **drone-delivered AEDs** are being piloted to address the challenge of rapid access in traffic-congested or remote areas, potentially bypassing ground-based logistical hurdles to get a defibrillator to the scene within minutes [35].

5. CPR Quality, Defibrillation, and Advanced Life Support

The cornerstone of effective professional resuscitation is the delivery of **high-quality CPR**. The SRCA's clinical practice guidelines emphasize specific metrics that define quality: chest compressions must be delivered at a rate of 100-120 per minute, at a depth of 5-6 centimeters for adults, with full chest recoil between compressions, and with minimal interruptions [41]. To achieve this consistently, the SRCA has increasingly integrated technological aids into practice. **Real-time audiovisual feedback devices** are now common on defibrillator pads. These devices provide paramedics with instant feedback on compression rate and depth, allowing for real-time corrections and maintaining adherence to the stringent guidelines that are difficult to achieve through manual assessment alone [42]. Furthermore, the SRCA has deployed **mechanical CPR devices** (such as the LUCAS™ or AutoPulse™) across many of its advanced life support units. These piston- or load-distributing-band devices provide uninterrupted, high-quality compressions regardless of environmental challenges, such as during patient movement from a confined space, down stairwells, or throughout the turbulent ambulance transport phase. This is crucial, as the quality of manual CPR invariably deteriorates during patient movement, and mechanical devices ensure perfusion is maintained during these critical transitions [43].

The single most critical intervention for a shockable rhythm is **rapid defibrillation**. The SRCA's protocol mandates that upon confirmation of OHCA, an AED or manual monitor-defibrillator is applied and the patient's rhythm analyzed at the earliest possible moment, ideally during the first cycle of CPR. All SRCA response vehicles are equipped with defibrillators capable of both manual and AED modes. For witnessed arrests with a shockable initial rhythm (Ventricular Fibrillation or Pulseless Ventricular Tachycardia), the protocol is to deliver a single shock, followed by immediate resumption of CPR for two minutes before the next rhythm check [44]. The strategic placement of these devices and the training that emphasizes speed and minimal interruption to compressions are designed to capitalize on the narrow therapeutic window for successful defibrillation. The success of this intervention is highly time-dependent; the probability of successful defibrillation decreases by approximately 7-10% with each passing minute from collapse [45]. Therefore, the SRCA's focus on reducing both response time and on-scene delay to first shock is a direct effort to maximize the number of patients who can benefit from this definitive treatment.

Beyond basic CPR and defibrillation, SRCA paramedics are trained and equipped to provide **Advanced Life Support (ALS)**. This involves advanced airway management and pharmacological therapy. The preferred method for advanced airway management is shifting towards the use of **supraglottic airways** (e.g., laryngeal mask airway - LMA) or, for highly trained paramedics, **endotracheal intubation**. The primary goal is to secure a patent airway to enable effective ventilation and prevent aspiration, without causing prolonged interruptions in chest compressions [46]. Concurrently, vascular access is established, typically through intraosseous (IO) access if intravenous (IV) access is difficult to obtain rapidly. The core pharmacological agents used align with international guidelines. **Epinephrine** (adrenaline) is administered every 3-5 minutes to stimulate alpha-adrenergic receptors, increasing coronary and cerebral perfusion pressure. For refractory Ventricular Fibrillation, **Amiodarone** is the antiarrhythmic of choice after the third shock [47]. The SRCA's drug protocols are regularly updated based on the latest evidence, ensuring that pre-hospital care is aligned with the most current resuscitation science.

A critical component of on-scene management is the **team dynamics and choreography** of the resuscitation attempt. SRCA crews train to function as a cohesive unit, with clear role allocation—one team leader, one managing compressions/mechanical device, one managing the airway and ventilation, and another preparing medications and managing the defibrillator. This structured approach minimizes chaos, ensures all tasks are completed efficiently, and reduces the "hands-off" time during which no compressions are being delivered [48]. The team leader is responsible for directing the resuscitation, tracking the timing of interventions (e.g., pulse checks, medication administration), and making the difficult decision to **terminate resuscitation efforts** in the field. Termination of resuscitation (TOR) protocols are applied in specific, bleak scenarios, such as when the arrest was not witnessed by EMS, there was no bystander CPR, there are no shockable rhythms, and there is no return of spontaneous circulation (ROSC) after full ALS efforts [49]. This avoids futile and resource-intensive transports of patients with no realistic chance of survival, allowing crews to become available for other emergencies.

Finally, the SRCA is exploring **point-of-care technologies** to guide resuscitation. The use of **capnography** is now standard. End-tidal CO2 (ETCO2) monitoring provides a continuous, non-invasive measure of CPR quality (higher ETCO2 values correlate with better cardiac output generated by compressions) and is the most reliable method for confirming endotracheal tube placement. Furthermore, a sudden rise in ETCO2 is a sensitive early indicator of the return of spontaneous circulation (ROSC), often detected before a palpable pulse [50]. The integration of **point-of-care ultrasound (POCUS)** is also under investigation for use in cardiac arrest to identify reversible causes like cardiac tamponade, massive pulmonary embolism, or profound hypovolemia, though its widespread implementation in the pre-hospital setting is still in its infancy in the Kingdom.

6. Conclusion

This comprehensive analysis has systematically examined the multifaceted role of the Saudi Red Crescent Authority (SRCA) in influencing out-of-hospital cardiac arrest (OHCA) survival rates across the Kingdom of Saudi Arabia. The findings reveal a complex and evolving emergency medical services (EMS) system that demonstrates significant technological advancement and clinical capability, yet faces substantial challenges in achieving optimal patient outcomes. The evidence confirms that the SRCA has made considerable progress in building a modern response infrastructure, with sophisticated computer-aided dispatch systems, advanced life support equipment,

and trained paramedic teams capable of delivering protocol-driven resuscitation care aligned with international standards.

The study identifies several critical determinants of OHCA survival within the Saudi context. First and foremost, the persistently low rates of bystander cardiopulmonary resuscitation (CPR)—consistently reported below 20%—emerge as the single most significant barrier to improved survival outcomes. This deficiency in the first link of the chain of survival fundamentally limits the effectiveness of even the most advanced professional response. Second, the urban-rural disparity in response times creates a geographical inequality in access to timely defibrillation, with rural communities facing particularly challenging odds for survival. Third, while the SRCA's clinical protocols and technological integration are robust, their impact is often diminished by external factors including traffic congestion, cultural barriers, and the high prevalence of non-shockable initial rhythms upon EMS arrival.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
- **Acknowledgement:** The authors declare that they have nobody or no-company to acknowledge.
- **Author contributions:** The authors declare that they have equal right on this paper.
- **Funding information:** The authors declare that there is no funding to be acknowledged.
- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

[1] Sasson C, Rogers MAM, Dahl J, et al. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes. 2010;3(1):63–81.

[2] Alsharari A, Alduraywish A, Al-Zarea E, et al. Current status of knowledge about cardiopulmonary resuscitation among the university students in the northern region of Saudi Arabia. Cardiol Res Pract. 2018;2018.

[3] Wissenberg M, Lippert FK, Folke F, Weeke P, Hansen CM, Christensen EF, et al. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. J Am Med Assoc. 2013;310(13):1377–84.

[4] Al Enizi B, Saquib N, Zaghloul M, et al. Knowledge and attitudes about basic life support among secondary school teachers in Al-Qassim, Saudi Arabia. Int J Health Sci. 2016;10(3):415–422.

[5] Huang LH, Ho YN, Tsai MT, et al. Response time threshold for predicting outcomes of patients with out-of-hospital cardiac arrest. Emerg Med Int. 2021;11:2021.

[6] Virani SS, Alonso A, Aparicio HJ, Benjamin EJ, Bittencourt MS, Callaway CW, et al. Heart disease and stroke statistics - 2021 update: a report from the American heart association. Circulation. 2021;143:E254–743.

[7] Lim SL, Smith K, Dyson K, Chan SP, Earnest A, Nair R, et al. Incidence and outcomes of out-of-hospital cardiac arrest in Singapore and Victoria: a collaborative study. J Am Heart Assoc. 2020;9(21):e015981.

[8] McNally B, Robb R, Mehta M, et al. Out-of-hospital cardiac arrest surveillance — Cardiac Arrest Registry to Enhance Survival (CARES), United States, October 1, 2005–December 31, 2010. MMWR Surveill Summ. 2011;60(8):1–19.

[9] Al-Mulhim MA, Alshahrani MS, Asonto LP, et al. Impact of epinephrine administration frequency in out-of-hospital cardiac arrest patients: a retrospective analysis in a tertiary hospital setting. J Int Med Res. 2019;47(9):4272–4283.

[10] Subki AH, Mortada HH, Alsallum MS, et al. Basic life support knowledge among a nonmedical population in Jeddah, Saudi Arabia: Cross-Sectional Study. Interact J Med Res. 2018;7(2):e10428.

[11] Alhabib KF, Batais MA, Almigbal TH, Alshamiri MQ, Altaradi H, Rangarajan S, et al. Demographic, behavioral, and cardiovascular disease risk factors in the Saudi population: results from the prospective urban rural epidemiology study (PURE-Saudi). BMC Public Health. 2020;20(1):1–14.

[12] Bin Salleeh HM, Gabralla KA, Leggio WJ, Al Aseri ZA. Out-of-hospital adult cardiac arrests in a university hospital in central Saudi Arabia. Saudi Med J. 2015;36(9):1071–5.

[13] Hawkes C, Booth S, Ji C, Brace-McDonnell SJ, Whittington A, Mapstone J, et al. Epidemiology and outcomes from out-of-hospital cardiac arrests in England. Resuscitation. 2017;110:133–40.

[14] Doan TN, Schultz BV, Rashford S, Bosley E. Surviving out-of-hospital cardiac arrest: the important role of bystander interventions. Australas Emerg Care. 2020;23(1):47–54.

[15] Alnajjar H, Hilal RM, Alharbi AJ, et al. Evaluation of awareness, knowledge, and attitudes towards basic life support among non-medical students at

two academic institutions in Jeddah, Saudi Arabia. Adv Med Educ Pract. 2020;11:1015.

[16] Berdowski J, Berg RA, Tijssen JGP, Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: systematic review of 67 prospective studies. Resuscitation. 2010;81(11):1479–87.

[17] Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the utstein resuscitation registry templates for out-of-hospital cardiac arrest. Circulation. 2015;132(13):1286–300.

[18] Wik L, Steen PA, Bircher NG. Quality of bystander cardiopulmonary resuscitation influences outcome after prehospital cardiac arrest. Resuscitation. 1994;28(3):195–203.

[19] Girotra S, van Diepen S, Nallamothu BK, Carrel M, Vellano K, Anderson ML, et al. Regional variation in out-of-hospital cardiac arrest survival in the United States. Circulation. 2016;133(22):2159–68.

[20] Gallagher EJ, Lombardi G, Gennis P. Effectiveness of bystander cardiopulmonary resuscitation and survival following out-of-hospital cardiac arrest. J Am Med Assoc. 1995;274(24):1922–5.

[21] Blom MT, Beesems SG, Homma PCM, Zijlstra JA, Hulleman M, van Hoeijen DA, et al. Improved survival after out-of-hospital cardiac arrest and use of automated external defibrillators. Circulation. 2014;130(21):1868–75.

[22] Lindner TW, Søreide E, Nilsen OB, Torunn MW, Lossius HM. Good outcome in every fourth resuscitation attempt is achievable-an utstein template report from the Stavanger region. Resuscitation. 2011;82(12):1508–13.

[23] Iwami T, Kawamura T, Hiraide A, Berg RA, Hayashi Y, Nishiuchi T, et al. Effectiveness of bystander-initiated cardiac-only resuscitation for patients with out-of-hospital cardiac arrest. Circulation. 2007;116(25):2900–7.

[24] Valenzuela TD, Roe DJ, Cretin S, Spaite DW, Larsen MP. Estimating effectiveness of cardiac arrest interventions: a logistic regression survival model. Circulation. 1997;96(10):3308–13.

[25] Pei-Chuan Huang E, Chiang WC, Hsieh MJ, Wang HC, Yang CW, Lu TC, et al. Public knowledge, attitudes and willingness regarding bystander cardiopulmonary resuscitation: a nationwide survey in Taiwan. J Formos Med Assoc. 2019;118(2):572–81.

[26] Holmberg M, Holmberg S, Herlitz J. Effect of bystander cardiopulmonary resuscitation in out-of-hospital cardiac arrest patients in Sweden. Resuscitation. 2000;47(1):59–70.

[27] Batt AM, Al-Hajeri AS, Cummins FH. A profile of out-of-hospital cardiac arrests in Northern Emirates, United Arab Emirates. Saudi Med J. 2016;37(11):1206.

[28] Cheskes S, McLeod SL, Nolan M, Snobelen P, Vaillancourt C, Brooks SC, et al. Improving access to automated external defibrillators in rural and remote settings: a drone delivery feasibility study. J Am Heart Assoc. 2020;9(14):16687.

[29] Claesson A, Fredman D, Svensson L, Ringh M, Hollenberg J, Nordberg P, et al. Unmanned aerial vehicles (drones) in out-of-hospital-cardiac-arrest. Scand J Trauma Resusc Emerg Med. 2016;24(1):1–9.

[30] Claesson A, Bäckman A, Ringh RNM, Svensson L, Nordberg P, Djärv T, et al. Time to delivery of an automated external defibrillator using a drone for simulated out-of-hospital cardiac arrests vs emergency medical services. J Am Med Assoc. 2017;317(22):2332–4.

[31] Derkenne C, Jost D, Miron De L'Espinay A, Corpet P, Frattini B, Hong V, et al. Automatic external defibrillator provided by unmanned aerial vehicle (drone) in greater Paris: a real world-based simulation. Resuscitation. 2021;162:259–65.

[32] Schierbeck S, Hollenberg J, Nord A, Svensson L, Nordberg P, Ringh M, et al. Automated external defibrillators delivered by drones to patients with suspected out-of-hospital cardiac arrest. Eur Heart J. 2022;43(15):1478–87.

[33] Conroy KM, Jolin SW. Cardiac arrest in Saudi Arabia: a 7-year experience in Riyadh. J Emerg Med. 1999;17(4):617–23.

[34] Qara FJ, Alsulimani LK, Fakeeh MM, et al. Knowledge of nonmedical individuals about cardiopulmonary resuscitation in case of cardiac arrest: a cross-sectional study in the population of Jeddah, Saudi Arabia. Emerg Med Int. 2019;2019:1–11.

[35] Shams A, Raad M, Chams N, et al. Community involvement in out of hospital cardiac arrest: a cross-sectional study assessing cardiopulmonary resuscitation awareness and barriers among the Lebanese youth. Medicine. 2016;95(43):e5091.

[36] Holmberg M, Holmberg S, Herlitz J, Gardelov B. Survival after cardiac arrest outside hospital in Sweden. Swedish Cardiac Arrest Registry. Resuscitation. 1998;36(1):29–36.

[37] Gräsner JT, Herlitz J, Tjelmeland IB, et al. European resuscitation council guidelines 2021: epidemiology of cardiac arrest in Europe. Resuscitation. 2021;161:61–79.

[38] Atwood C, Eisenberg MS, Herlitz J, et al. Incidence of EMS-treated out-of-hospital cardiac arrest in Europe. Resuscitation. 2005;67(1):75–80.

[39] Hasselqvist-Ax I, Riva G, Herlitz J, et al. Early cardiopulmonary resuscitation in out-of-hospital cardiac arrest. N Engl J Med. 2015;372(24):2307–2315.

[40] Holmberg M, Holmberg S, Herlitz J, Axelsson C. Survival after cardiac arrest outside hospital over a 12-year period in Gothenburg. Resuscitation. 1994;27(3):181–7.

[41] Eisenberg MS, Bergner L, Hallstrom A. Cardiac resuscitation in the community. Importance of rapid provision and implications for program. J Am Med Assoc. 1979;241(18):1905–7.

[42] Holmberg M, Holmberg S, Herlitz J. Incidence, duration and survival of ventricular fibrillation in out-of-hospital cardiac arrest patients in Sweden. Resuscitation. 2000;44(1):7–17.

[43] Reades R, Studnek JR, Vandeventer S, et al. Intraosseous versus intravenous vascular access during out-of-hospital cardiac arrest: a randomized controlled trial. Ann Emerg Med. 2011;58(6):509–516.

[44] McMullan J, Gerecht R, Bonomo J, et al. Airway management and out-of-hospital cardiac arrest outcome in the CARES registry. Resuscitation. 2014;85(5):617–622.

[45] Holmén J, Herlitz J, Ricksten SE, et al. Shortening ambulance response time increases survival in out-of-hospital cardiac arrest. J Am Heart Assoc. 2020;9(21):e017048.

[46] Scquizzato T, D'Amico F, Rocchi M, et al. Impact of COVID-19 pandemic on out-of-hospital cardiac arrest system-of-care: a systematic review and meta-analysis. Prehosp Emerg Care. 2021:1–12.

[47] Baldi E, Sechi GM, Mare C, et al. Out-of-hospital cardiac arrest during the covid-19 outbreak in Italy. N Engl J Med. 2020;383(5):496–498.

[48] Couper K, Taylor-Phillips S, Grove A, et al. COVID-19 in cardiac arrest and infection risk to rescuers: a systematic review. Resuscitation. 2020;151:59–66.

[49] McCarthy JJ, Carr B, Sasson C, et al. Out-of-hospital cardiac arrest resuscitation systems of care: a scientific statement from the American Heart Association. Circulation. 2018;137(21):e645–e660.

[50] Stiles MK, Wilde AAM, Abrams DJ, Ackerman MJ, Albert CM, Behr ER, et al. 2020 APHRS/HRS expert consensus statement on the investigation of decedents with sudden unexplained death and patients with sudden cardiac arrest, and of their families. Heart Rhythm. 2021;18(1):e1–50.